FINAL REPORT

Advanced Theoretical and Experimental Studies in Automatic Control and Information Systems

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Principal Investigators

C. A. Desoer/E. Polak/L. A. Zadeh

ELECTRONICS RESEARCH LABORATORY

College of Engineering
University of California, Berkeley
94720

Over a ten-year period a sequence of projects were undertaken in the following areas: (i) mathematical programming problems for large system and infinite-dimensional spaces [9,19,21,28], (ii) Bounded-input bounded-output stability, (iii) non-parametric approximations [43,62] and (iv) differential games [56,92,96]. Since the time that these projects were completed all these areas, with the exception of (iii), have attracted a great deal of effort in the profession.

Looking over our list of publications for the last ten years, we see that we have made a number of important contributions to the theory of optimal control, to game theory, to systems theory and to optimization. To review a sample of the papers which were published, [4,12] were the first papers in the literature to develop maximum principle type conditions for discrete optimal control theory, [27] has been recognized as a classical paper in the theory of general optimality conditions, [36,38] are always referenced in papers dealing with vector optimization problems, and are often referred to in the literature on differential games. References [39,40] are further contributions to game theory. Reference [38] presented a widely recognized method for linear system identification; [23] and [46] were other contributions to linear system theory. Over the years we have developed a large number of new and highly efficient optimization algorithms [51,57,60,81,88,97,98,99,105,106, 108,109,110,120,123] and we have developed a series of very powerful tools to the analysis and synthesis of optimization algorithms [76,83,87, 93,99,103,104,108,128,130]. All in all, the last five years were a highly successful period in our research.

A major part of the effort was put on the problem of stability of feedback systems. For nonlinear systems; [7] is a classic reference on

the Popov criterion, for L^p-stability, [65] and [122] are basic references. For linear systems [52,78,100,101,107,119] represent a succession of increasingly general and sophisticated results which are widely quoted. The best known result concerning the Nyquist graphical test is in [113]. An overview of all this work on stability together with the work of many others is to be found in [131]. Reference [80] tackles the problem of optimizing characteristics, a technique taken up later by Peikari. Singular perturbation were considered in [68,89,90,121]. A basic misconception in minimal realization was resolved in [22].

During the past ten years, the main thrust of our research was directed at the development of approximate techniques for dealing with the system that are too complex or too ill-defined to be amenable to analysis by conventional quantitation methods.

To this end, the notion of a fuzzy algorithm was introduced in [55]. In [69], a framework for the analysis of fuzzy systems was set up and in [94] the problem of decision-making in a fuzzy environment was formulated. This work culminated in the development of the so-called linguistic approach [124], in which words or sentences rather than numbers are employed to describe phenomena which are not susceptable of quantitative characterization. This approach shows considerable promise as an effective tool for the analysis of large scale systems.

III. LIST OF REPORTS AND PAPERS

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